UTILITY PATENT APPLICATION
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Case Docket No.: CIT/K-085A

Transmitted herewith for filing is the patent application of
INVENTOR OR APPLICATION IDENTIFIER: Hyun Mun KIM, Jong Beom RA, Sung Deuk KIM and Young Su LEE
FOR: METHOD OF REDUCING A BLOCKING ARTIFACT WHEN CODING MOVING PICTURE
Enclosed are:

1. [X]   21 pages of specification, claims, abstract

2. [X]   3 sheets of FORMAL drawings.

3. [X]   2 pages of Declaration & Power of Attorney (copy from a prior application).
   [X] Incorporation By Reference-The entire disclosure of the prior application is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.
   [X] This is a Continuation of prior application No. 09/010,446 filed January 22, 1998, entitled **METHOD OF REDUCING A BLOCKING ARTIFACT WHEN CODING MOVING PICTURE**

4. [X]   An Information Disclosure Statement and PTO 1449 Form are submitted herewith.

5. [ ]   Cancel claims _____.

6. The filing fee is calculated on the basis of the claims existing in the prior application as amended at 5 above:

For	No. Filed		No. Extra	Rate	Fee
Total Claims	20	- 20	0	X $18.00	
Indep. Claims	2	- 3	0	X $78.00	
Multiple Dependent Claims (If applicable) add $260.					
				BASIC FEE	$690.00
				TOTAL FILING FEE	$690.00

7. [ ]   Preliminary Amendment is enclosed.

8a. [ ]   Enclosed is a Small Entity Statement.

8b. [ ]   A Small Entity Statement was filed in prior application and such status is still proper and desired.

9a. [X]   A check in the amount of $ 690.00 (Check # 8356) is attached.

9b. [ ]   Please charge my Deposit Account No. 16-0607 in the amount of $__. A duplicate copy of this sheet is enclosed.

9c. [X]   The Commissioner is hereby authorized to charge payment of the following fees associated with this communication or credit any overpayment to Deposit Account No. 16-0607. A duplicate copy is enclosed.

[X]   Any additional filing fees required under 37 C.F.R. 1.16.

10a. [X]   The Commissioner is hereby authorized to charge fees under 37 C.F.R. 1.16 and 1.17 which may be required, including any extension of time fees to maintain the pendency of the parent application No. 09/010,446, or credit any overpayment to Deposit Account No. 16-0607.

10b. [X] Authorization under 37 C.F.R. §1.136(a)(3).

11. [X] Amend the specification by inserting before the first line the sentence:

--This application is a Continuation of Application No. 09/010,446 filed January 22, 1998.--

12. [X] Priority of Application Serial No. 36231/1997 filed on July 30, 1997, in Republic of Korea is claimed under 35 U.S.C. 119. The certified priority document was filed in Serial No. 09/010,446 on January 22, 1998.

13. [X] The prior application is assigned of record to LG ELECTRONICS INC. at Reel 10060, Frame 0771

14. [X] The power of attorney in the prior application is to:

FLESHNER & KIM, LLP

15. [X] Two (2) return postcards.
        [X] Stamp & Return with Courier.
        [X] Prepaid Postcard-Stamped Filing Date & Returned with Unofficial Serial Number.

16. [ ]   Also enclosed:

17. [ ]   A petition, fee and response has been filed to extend the term in the pending prior application until _____.

Respectfully submitted,
FLESHNER & KIM, LLP

Daniel Y.J. Kim
Registration No. 36,186

Correspondence Address Below:
P.O. Box 221200
Chantilly, VA 20153-1200
(703) 502-9440 DYK:jld
Date: February 18, 2000

APPLICATION FOR UNITED STATES LETTERS PATENT

INVENTORS: Hyun Mun KIM, Jong Beom RA, Sung Deuk KIM and Young Su
LEE

TITLE: METHOD OF REDUCING A BLOCKING ARTIFACT WHEN
CODING MOVING PICTURE

ATTORNEYS: The Law Offices of
&   FLESHNER & KIM
ADDRESS: P. O. Box 221200
Chantilly, VA 20153-1200

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METHOD OF REDUCING A BLOCKING ARTIFACT WHEN CODING MOVING PICTURE

BACKGROUND OF THE INVENTION

5   1.   Field of the Invention

The present invention relates to a moving picture process, and in particular to a

method for processing blocks of a moving picture to increase a compression ratio and to

improve coding efficiency.

10   2.   Background of the Related Art

To efficiently compress a time variable video sequence, redundancy in the temporal

domain as well as in the two dimensional spatial domain must be reduced. MPEG uses a

discrete cosine transform (DCT) to reduce the redundancy in the two dimensional spatial

domain and a motion compensation method to reduce the redundancy in the temporal

15   domain.

The DCT is a method of reducing the correlativity between data through a two

dimensional spatial transformation. Each block in a picture is spatially transformed using

the DCT after the picture is divided into blocks. Data that has been spatially transformed

tends to be driven to a certain direction. Only a group of the data driven in the certain

20   direction is quantized and transmitted.

Pictures, which are consecutive in the temporal domain, form motions of a human being or an object at the center of the frame. This property is used to reduce the redundancy of the temporal domain in the motion compensation method. A volume of data to be transmitted can be minimized by taking out a similar region from the preceding picture to fill a corresponding region, which has not been changed (or has very little change), in the present picture. The operation of finding the most similar blocks between pictures is called a motion estimation. The displacement representing a degree of motion is called a motion vector. MPEG uses a motion compensation-DCT method so that the two methods combine.

When a compression technique is combined with a DCT algorithm, the DCT transform is usually performed after input data is sampled in a unit size of 8 × 8, and the transform coefficients are quantized with respect to a visual property using quantization values from a quantization table. Then, the data is compressed through a run length coding (RLC). The data processed with the DCT is converted from a spatial domain to a frequency domain and compressed through the quantization with respect to the visual property of human beings, not to be visually recognized. For example, since eyes of human beings are insensitive to a high frequency, a high frequency coefficient is quantized in a large step size. Thus, a quantization table is made according to external parameters,

such as a display characteristic, watching distance, and noise, to perform an appropriate quantization.

For the quantized data, the data having a relatively high frequency is coded with a short code word. The quantized data having a low frequency is coded with a long code word. Thus, the data is finally compressed.

In processing a moving picture as discussed above, blocks are individually processed to maximize the compression ratio and coding efficiency. However, the individual process causes blocking artifacts that disturb the eyes of human beings at boundaries between blocks.

Accordingly, various methods for reducing a blocking artifact in a coding system, which individually processes blocks, are presented. For example, attempts to reduce the blocking artifact by changing processes of coding and decoding have been implemented. However, this method of changing the processes of coding and decoding increases the amount of bits to be transmitted.

Another method for reducing the blocking artifact is based on the theory of projection onto convex sets (POCS). However, this method is applied to only a still picture because of an iteration structure and convergence time.

The blocking artifact is a serious problem in a low transmit rate moving picture compression. Since a real-time operation is necessary in coding and decoding a moving picture, it is difficult to reduce the blocking artifact with a small operation capacity.

Consequently, the related art methods involve various problems and disadvantages when reducing a blocking artifact created in coding a moving picture. A calculation for performing an algorithm is complicated, and the calculation amount and time become correspondingly large. Further, the blocking artifacts are not reduced in either complex regions or smooth regions in a picture. In addition, the amount of bits to be transmitted increases.

The above references are incorporated by reference herein where appropriate for appropriate teachings of additional or alternative details, features and/or technical background.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a method for reducing a blocking artifact appearing when coding a moving picture that substantially obviates one or more of the limitations and disadvantages of the related art.

Another object of the present invention is to provide an MPEG-4 video coding method that reduces a blocking artifact in a real-time moving picture using a frequency property around boundaries between blocks.

A further object of the present invention is to provide a method for reducing a blocking artifact that increases a compression ration and increases a coding efficiency.

To achieve these and other advantages in whole or in parts, and in accordance with the purpose of the present invention as embodied and broadly described, a blocking artifact reduction method includes defining pixels centered around a block boundary and setting a default mode. Frequency information of the surroundings of the block boundary is obtained for each pixel using a 4-point kernel. A magnitude of a discontinuous component that belongs to the block boundary is adjusted in a frequency domain to a minimum value of a magnitude of a discontinuous component that belongs to the surrounding of the block boundary. The adjusting operation is then applied to a spatial domain. In addition, a DC offset mode is established, and in the DC offset mode the blocking artifact is also reduced, for example, in a smooth region where there is little motion.

Additional advantages, objects, and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from

practice of the invention. The objects and advantages of the invention may be realized

and attained as particularly pointed out in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

5   The invention will be described in detail with reference to the following drawings

in which like reference numerals refer to like elements wherein:

    FIG. 1 is a diagram that illustrates horizontal and vertical block boundaries;

    FIG. 2 is a diagram that illustrates a 4-point DCT kernel; and,

    FIG. 3 is a flow chart that illustrates a preferred embodiment of a method that

10 reduces a blocking artifact when coding a moving picture according to the present

invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

    Reference will now be made to preferred embodiments of the present invention,

15 examples of which are illustrated in the accompanying drawings. FIG. 1 illustrates typical

horizontal and vertical block boundaries.

    As shown in FIG. 1, in the dimensional image formed with respective four points

of S_0, S_1, and S_2 located around the block boundary, S_1 and S_2 are individually processed

with a block-unit compression method. Thus, S_1 and S_2 are not influenced by the

blocking artifact. However, S_0 is located across a block boundary. Thus, S_0 is directly influenced by the blocking artifact. The blocking artifact appears at the boundary between fixed block patterns in the form of a line of discontinuity.

Preferred embodiments of the present invention use, for example, a frequency property to preserve complex regions at block boundaries. The frequency property around the boundary is preferably obtained by using a 4-point DCT kernel, which can be easily calculated. However, the present invention is not intended to be limited to this. In this case, the complex region at a block boundary can be effectively processed by extending the smoothness of a picture from a frequency domain to a spatial domain.

As shown in FIG. 1, S_0 is located across the block boundary. Thus, S_0 is directly influenced by the blocking artifact. To reduce the blocking artifact from S_0, a first preferred embodiment of the present invention uses frequency information in S_1 and S_2. The blocking artifact can be removed from S_0 by replacing the frequency component in S_0, which is influenced by the blocking artifact, with the frequency components of S_1 and S_2. In other words, S_0 contains a discontinuity. However, S_1 and S_2, which are completely included inside respective blocks, are not related to the discontinuity. Since S_1 and S_2 are not involved with the discontinuity at a block boundary, S_1 and S_2 can accurately represent features of the respective neighboring blocks.

When images change smoothly, image features of S_0, S_1 and S_2 are similar. This means that frequency domains of S_0, S_1 and S_2 have similar features. The preferred embodiments use a DCT, or the like as a frequency analysis tool. DCT is widely used in an image compression technique

5   FIG. 2 is a diagram illustrating a 4-point DCT basis. As shown in FIG. 2, the 4-point DCT kernel basis has symmetric and anti-symmetric properties around the center of 4 points. In FIG. 2, $a_{0,0}$, $a_{1,0}$, $a_{2,0}$, and $a_{3,0}$ are defined as the 4-point DCT coefficients of S_0. Although both $a_{2,0}$, and $a_{3,0}$ are high frequency components, $a_{2,0}$ is symmetric, and $a_{3,0}$ is anti-symmetric around the center.

10   The center of S_0 is located at a block boundary as shown in FIG. 1. Thus, a factor directly affecting the block discontinuity is not the symmetric component but the anti-symmetric component. The magnitude of $a_{3,0}$ in a frequency domain is thus adjusted based on the anti-symmetric component being a major factor affecting the discontinuity. Accordingly, the proper adjustment of $a_{3,0}$ is directly related to the reduction of block

15   discontinuity in the spatial domain. Reduction of the block discontinuity will now be described.

In a first preferred embodiment, the magnitude of $a_{3,0}$ is replaced with the minimum value of the magnitudes of $a_{3,1}$ and $a_{3,2}$, which are contained in a single block in an area surrounding a block boundary. By doing this, a large blocking artifact that appears

when one side of the block boundary to be processed is smooth can be reduced. For a complex image where both S1 and S2 are the objects of motion (i.e., all the values of the magnitudes of $a_{3,0}$, $a_{3,1}$ and $a_{3,2}$ are large), there is little influence on the block boundary.

A method for reducing a blocking artifact in a default mode is as follows:

5

$$v_3' = v_3 - d;$$

$$v_4' = v_4 + d; \text{ and}$$

$$d = CLIP\ (c_2(a_{3,0}' - a_{3,0})//c_3, 0, (v_3 - v_4)/2) * \delta(|a_{3,0}| \langle QP).$$

In the method, $a_{3,0}' = SIGN(a_{3,0}) * MIN(|a_{3,0}|, |a_{3,1}|, |a_{3,2}|)$, and c_i is the component of DCT kernel. The condition $|a_{3,0}| \langle QP$ is used to count the influence of the quantization

10 parameter on the blocking artifact. The $|a_{3,0}| < QP$ condition also prevents over-smoothing when the blocking artifact is not very serious. The clipping operation on the compensated value prevents the direction of the gradient at the boundary from being large or changed in an opposite direction. The boundary pixel values, v_3 and v_4, are replaced with v_3' and v_4'. QP is the quantization parameter of the macroblock where v_4 belongs.

15 Values, c_1, c_2, and c_3 are kernel constants used in the 4-point DCT. To simplify an equation according to a first preferred embodiment of the present invention, the values of c_1 and c_2 are approximated to an integer, and the value of c_3 is approximated to a multiple of 2. The values of a_1, a_2, and a_3 are evaluated from the simple inner product of the DCT kernel and pixels, S_0, S_1, and S_3.

$$a_{3,0} = ([c_1 \; -c_2 \; c_2 \; -c_1]^*[v_2 \; v_3 \; v_4 \; v_5]^T)/c_3$$

$$a_{3,0} = ([c_1 \; -c_2 \; c_2 \; -c_1]^*[v_0 \; v_1 \; v_2 \; v_3]^T)/c_3$$

$$a_{3,0} = ([c_1 \; -c_2 \; c_2 \; -c_1]^*[v_4 \; v_5 \; v_6 \; v_7]^T)/c_3$$

Such processes are performed in both horizontal and vertical block boundaries. In this manner, the blocking artifacts in the whole frame can be reduced.

The first embodiment reduces a blocking artifact in the default mode. However, in the default mode, only the boundary pixel values, v_3 and a_4, are compensated. Thus, the default mode is not sufficient to reduce the blocking artifact in a very smooth region, such as a setting in a picture.

To reduce the blocking artifact in the smooth region, a second preferred embodiment of a method for reducing blocking artifacts in a moving picture according to the present invention includes a DC offset mode. The method in the DC offset mode is as follows:

$$v_3{}' = v_3 - d;$$

$$v_4{}' = v_4 + d;$$

$$v_2{}' = v_2 - d_2;$$

$$v_5{}' = v_5 + d_2;$$

$$v_1{}' = v_1 - d_3; \text{ and}$$

$$v_6{}' = v_6 + d_3.$$

In the second preferred embodiment,

$$d_1 = (3(v_3 - v_4)//8)*\delta(|a_{3,0}|\langle QP),$$

$$d_2 = (3(v_3 - v_4)//16)*\delta(|a_{3,0}|\langle QP), \text{ and}$$

$$d_3 = (3(v_3 - v_4)//32)*\delta(|a_{3,0}|\langle QP).$$

The blocking artifact in the region where there is little motion, or which is a very small setting, is reduced through the above-described method or the like in the DC offset mode. An appropriate mode between the DC offset mode and default mode can be determined using on the following conditional expression:

If $(v_0 == v_1 \&\& v_1 == v_2 \&\& v_2 == v_3 \&\& v_4 == v_5 \&\& v_5 == v_6 \&\& v_6 == v_7)$

DC offset mode is applied; Else Default mode is applied.

When the DC offset mode or the default mode is selected according to the above conditional expression, the blocking artifacts are reduced in each mode. After determining the proper mode between the DC offset mode and the default mode, the block discontinuity at the boundary is compensated to form a consecutive line, which reduces the blocking artifact. In the second preferred embodiment, the DC offset mode and the default mode are set using S_0, S_1 and S_2. However, the present invention is not intended to be limited to this. Alternative sets of points or the like can be used.

An examplary method for reducing a blocking artifact when coding a moving

picture, according to the second preferred embodiment of the present invention, is

described with reference to the flow chart shown in FIG. 3.

After beginning in FIG. 3, control continues to step 101. In step 101, a plurality

of pixels, S0, S1, and S2 are defined centering around a block boundary. From step 101,

control continues to step 102. In step 102, if a mode is selected, a default mode is set, and

control continues to step 103.

In step 103, frequency information of the surroundings of the block boundary for

each pixel is obtained using, for example, the 4-point DCT kernel. From step 103, control

continues to step 104. In step 104, the magnitude of discontinuous component belonging

to the block boundary is replaced with the minimum magnitude of the discontinuous

components belonging to the surroundings of the block boundary in the frequency

domain. From step 104, control continues to step 105, where the adjusting operation is

applied to the spatial domain. The default mode is effective in reducing the blocking

artifact in a complex region of a picture. However, the default mode is less successful in

a smooth region such as a setting in a picture.

Therefore, in a smooth region it is necessary to reduce the blocking artifact in

another mode, the DC offset mode. In step 106, the DC offset mode is established. From

step 106, control continues to step 107. In step 107, the blocking artifact in the region

where there is little motion, such as a setting, is reduced. From step 107, the process ends. Thus, the overall blocking artifacts can be reduced according to the preferred embodiments.

As described above, the blocking artifact reduction methods according to the preferred embodiments of the present invention have various advantages and effects. The blocking artifact is more easily and effectively reduced using features of the frequency domain. The preferred embodiments provide a visually finer quality of a picture by reducing the blocking artifacts in both the complex and smooth regions. Further, calculations are simple. Accordingly, the amount of bits does not increase.

The foregoing embodiments are merely exemplary and are not to be construed as limiting the present invention. The present teaching can be readily applied to other types of apparatuses. The description of the present invention is intended to be illustrative, and not to limit the scope of the claims. Many alternatives, modifications, and variations will be apparent to those skilled in the art.

WHAT IS CLAIMED IS:

1.   A method coding a moving picture using a plurality of blocks, comprising the steps of:

selecting a plurality of pixels positioned around a block boundary;

obtaining frequency information for each of the plurality of pixels;

adjusting a discontinuous component in a frequency domain of a first pixel of the plurality of pixels located at the block boundary based on a corresponding component in the frequency domain of a second pixel of the plurality of pixels near the block boundary; and

applying the adjusting operation to a spatial domain of the first pixel to reduce a blocking artifact.

2.   The method according to claim 1, wherein the selecting through applying steps are performed in a first mode.

3.   The method according to claim 1, wherein a magnitude of the discontinuous component in the first pixel is adjusted to a magnitude of the corresponding component in the second pixel, wherein the magnitude of the corresponding component in the second

pixel is based on a smallest value of corresponding component magnitudes in remaining pixels of the plurality of pixels.

4. The method according to claim 3, wherein the adjusting step satisfies at least one of the following conditions:

$v_3' = v_3 - d$; and

$v_4' = v_4 + d$; where $d = $ CLIP $(c_2(a_{3,0}' - a_{3,0})//c_3, 0, (v_3 - v_4)/2) * \delta(|a_{3,0}| \langle QP)$,

$a_{3,0}' = $ SIGN$(a_{3,0}) * $ MIN$(|a_{3,0}|, |a_{3,1}|, |a_{3,2}|)$, wherein $v_3 - v_4$ are initial boundary pixel values, $v_3' - v_4'$ are adjusted boundary pixel values, $a_{3,0} - a_{3,2}$ are the discontinuous component of the discrete cosine transform coefficients of the first and second pixels, c_2 and c_3 are DCT kernel coefficients and QP is a quantization parameter of a macroblock containing v_4.

5. The method according to claim 3, wherein the remaining pixels of the plurality of pixels are positioned within a block adjacent the block boundary.

6. The method according to claim 1, further comprising:
determining a smoothness level of the plurality of pixels; and

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selecting one of a first and a second mode based on the smoothness level, wherein the blocking artifact is reduced based on the selected mode.

7.   The method according to claim 6, wherein the second mode is selected when the following condition is satisfied: $(v_0 == v_1 \&\& v_1 == v_2 \&\& v_2 == v_3 \&\& v_4 == v_5 \&\& v_5 == v_6 \&\& v_6 == v_7)$, wherein v_0 - v_7 are boundary pixel values.

8.   The method according to claim 6, wherein in the second mode is selected for a region of the motion picture where there is little motion.

9.   The method according to claim 8, wherein the adjusting step prevents over-smoothing when the blocking artifact is not very serious and counts an effect of a quantization parameter.

10.   The method according to claim 6, wherein the adjusting step in the second mode satisfies at least one of the following conditions:

$$v_3' = v_3 - d;$$

$$v_4' = v_4 + d;$$

$$v_2' = v_2 - d_2;$$

5

$v_5' = v_5 + d_2$;

$v_1' = v_1 - d_3$; and

$v_6' = v_6 + d_3$, where $d_1 = (3(v_3 - v_4)//8)*\delta(|a_{3,0}| \langle QP)$,

$d_2 = (3(v_3 - v_4)//16)*\delta(|a_{3,0}| \langle QP)$, and

$d_3 = (3(v_3 - v_4)//32)*\delta(|a_{3,0}| \langle QP)$, wherein $v_0 - v_7$ are initial boundary pixel values, $v_1' - v_6'$ are adjusted boundary pixel values, $a_{3,0}$ is the discontinuous component of the discrete cosine transform coefficients of the first pixel and QP is a quantization parameter of a macroblock containing v_4.

11. The method according to claim 1, wherein the obtaining frequency information step uses a 4-point discrete cosine transform (DCT) kernel.

12. The method according to claim 11, wherein the plurality of pixels includes S_0, S_1, and S_2 pixels centered around the block boundary, and wherein corresponding DCT coefficients are determined by an inner product of the DCT kernel and the pixels, S_0, S_1, and S_2.

13. The method according to claim 1, wherein the plurality of pixels are centered around the block boundary.

14. The method according to claim 1, wherein a first mode is a default mode and a second mode is a DC offset mode.

15. A method of reducing a blocking artifact for use in coding a moving picture, comprising the steps of:

defining at least first, second and third pixels around a block boundary;

setting a default mode, if the default mode is selected;

obtaining frequency information for each of the pixels;

adjusting a magnitude of a discontinuous component in a frequency domain belonging to the block boundary to the minimum value of a magnitude of a discontinuous component in a frequency domain around the block boundary, and applying a result of the frequency domain adjusting operation to a spatial domain;

setting a DC offset mode, if a DC offset mode is selected; and

reducing the blocking artifact in at least one of the default mode and the DC offset mode.

16. The method according to claim 15, wherein the magnitude of the discontinuous component in the first pixel is adjusted to the minimum value of the magnitude of corresponding components in one of the second and third pixels, wherein

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the first pixel is located at the block boundary and the second and third pixels are located

5   around the block boundary.

17.   The method according to claim 16, wherein the adjusting steps in the default

mode are:

$$v_3' = v_3 - d; \text{ and}$$

$$v_4' = v_4 + d; \text{ where } d = CLIP(c_2(a_{3,0}' - a_{3,0})//c_3 0, (v_3 - v_4)/2) * \delta(|a_{3,d}| \langle QP),$$

$$a_{3,0}' = SIGN(a_{3,0}) * MIN(|a_{3,0}|, |a_{3,1}|, |a_{3,2}|), \text{ wherein } v_3 -$$

v_4 are initial boundary pixel values, $v_3' - v_4'$ are adjusted boundary pixel values, $a_{3,0} - a_{3,2}$

are the discontinuous component of the discrete cosine transform coefficients of the first

and second pixels, c_2 and c_3 are DCT kernel coefficients and QP is a quantization

parameter of a macroblock containing v_4.

18.   The method according to claim 15, wherein the default mode and the DC

offset mode are selected based on a smoothness level of at least the block boundary.

19. The method according to claim 18, wherein the adjusting steps in the DC offset mode are:

$$v_3' = v_3 - d;$$

$$v_4' = v_4 + d;$$

$$v_2' = v_2 - d_2;$$

$$v_5' = v_5 + d_2;$$

$$v_1' = v_1 - d_3; \text{ and}$$

$$v_6' = v_6 + d_3, \text{ where } d_1 = (3(v_3 - v_4)//8) * \delta(|a_{3,0}| \langle QP),$$

$$d_2 = (3(v_3 - v_4)//16) * \delta(|a_{3,0}| \langle QP), \text{ and}$$

$$d_3 = (3(v_3 - v_4)//32) * \delta(|a_{3,0}| \langle QP), \text{ wherein } v_0 - v_7 \text{ are}$$

initial boundary pixel values, $v_1' - v_6'$ are adjusted boundary pixel values, $a_{3,0}$ is the discontinuous component of the discrete cosine transform coefficients of the first pixel and QP is a quantization parameter of a macroblock containing v_4.

20. The method according to claim 15, wherein discrete cosine transform coefficients are determined by an inner product of a discrete cosine transform kernel and the pixels.

ABSTRACT OF THE DISCLOSURE

A method of coding a moving picture is provided that reduces blocking artifacts. The method can include defining a plurality of defining pixels S_0, S_1, and S_2, which are centered around a block boundary. If a default mode is selected then frequency information of the surroundings of the block boundary is obtained. A magnitude of a discontinuous component in a frequency domain belonging to the block boundary is adjusted based on a magnitude of a corresponding discontinuous component selected from a pixel contained entirely within a block adjacent the block boundary. The frequency domain adjustment is then applied to a spatial domain. Or, a DC offset mode can be selected to reduce blocking artifacts in smooth regions where there is little motion.

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FIG.1

(block boundary)

FIG.2

block boundary

FIG.3

```
                    ┌─────────────────┐
                    │      start      │
                    └─────────────────┘
                             │
                             ▼
           ┌──────────────────────────────┐
           │ define pixel s₀, s₁ and s₂   │
           │ centering around block       │──── 101
           │ boundary in default          │
           │ mode.                        │
           └──────────────────────────────┘
                             │
                             ▼
           ┌──────────────────────────────┐
           │ if default mode is           │──── 102
           │              selected        │
           └──────────────────────────────┘
                             │
                             ▼
           ┌──────────────────────────────┐
           │ obtain frequency inform-     │
           │ ation of the surroundings    │
           │ of block boundary for        │──── 103
           │ each pixel, using 4-point    │
           │ kernel.                      │
           └──────────────────────────────┘
                             │
                             ▼
           ┌──────────────────────────────┐
           │ adjust magnitude of dis-     │
           │ continuous component,        │
           │ belonging to block boun-     │
           │ dary to minimum value of     │──── 104
           │ magnitude of discontinuous   │
           │ component belonging to the   │
           │ surrounding of block bound-  │
           │ ary in frequency domain.     │
           └──────────────────────────────┘
                             │
                             ▼
           ┌──────────────────────────────┐
           │ apply the adjusting oper-    │
           │ ation in the frequency       │──── 105
           │ domain to spatial domain     │
           └──────────────────────────────┘
                             │
                             ▼
           ┌──────────────────────────────┐
           │ if DC offset mode            │
           │              is selected     │──── 106
           └──────────────────────────────┘
                             │
                             ▼
           ┌──────────────────────────────┐
           │ reduce blocking artifact     │
           │ in smooth region where       │──── 107
           │ there is little motion.      │
           └──────────────────────────────┘
                             │
                             ▼
                    ┌─────────────────┐
                    │       end       │
                    └─────────────────┘
```
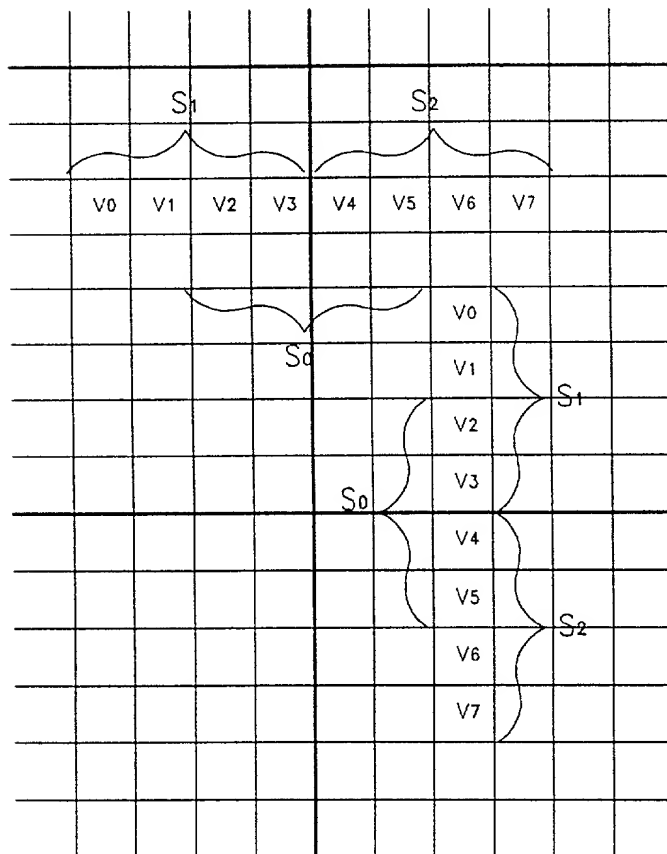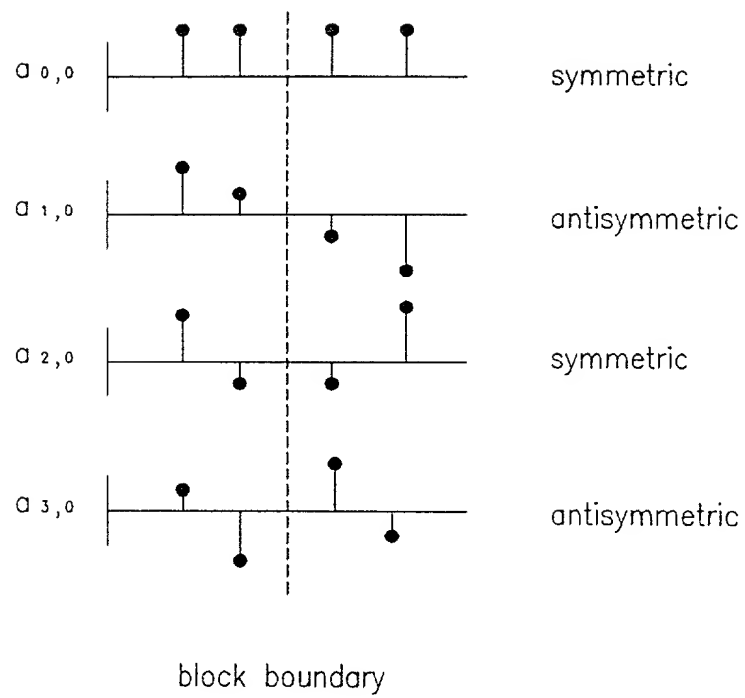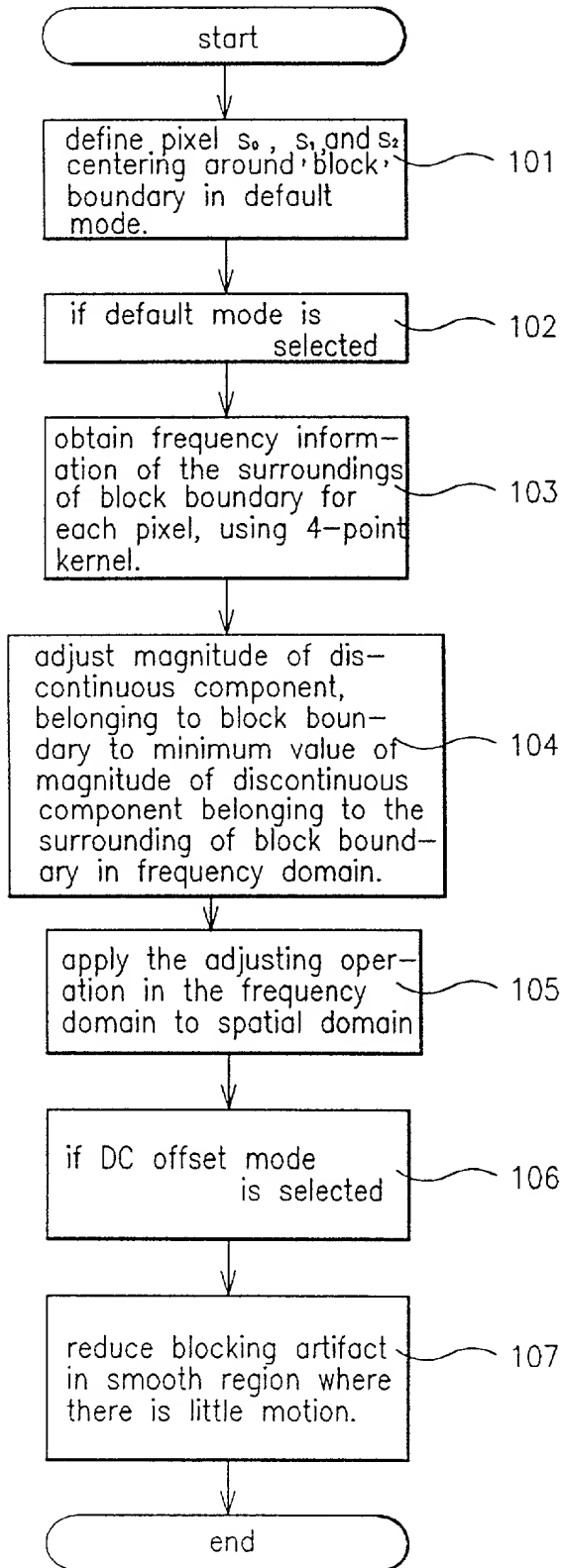
Docket No.:   LGS/K-029

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter claimed and for which a patent is sought on the invention entitled METHOD OF REDUCING A BLOCKING ARTIFACT WHEN CODING MOVING PICTURE, the specification of which

[ ] is attached hereto   [X] was filed on January 22, 1998 as Application Serial No. 09/010,446 and was
                              amended on _____ (if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is known to me to be material to patentability in accordance with Title 37, Code of Federal Regulations, Section 1.56(a).

I hereby claim foreign priority or provisional application benefits under Title 35, United States Code, Section 119 of any foreign application(s) for patent or inventor's certificate, or provisional application(s) listed below and have also identified below any foreign application for patent or inventor's certificate, or provisional application(s) having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s) or U.S. Provisional Application(s):   Priority Claimed

Number	Country	Day/Month/Year	Yes	No
36231/1997	Korea	30 July 1997	X	

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, Section 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

Prior U. S. Application(s):

Serial No.	Filing Date	Status: Patented, Pending, Abandoned

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

I hereby appoint the following attorney(s) and/or agent(s):Daniel Y.J. Kim, Registration No. 36,186 and Mark L. Fleshner, Registration No. 34,596; Carl R. Wesolowski, Registration No. 40,372, John C. Eisenhart, Registration No. 38,128, and Rene A. Vazquez, Registration No. 38,647, all of

FLESHNER & KIM
P. O. Box 221200
Chantilly, Virginia 20153-1200

with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith, and all future correspondence should be addressed to them.

****

Full name of sole or first inventor: Hyun Mun KIM

Inventor's signature: _K 갼 갼_   Date: 2/1/99

Residence: Rockville, Maryland, U.S.A.

Citizenship: Republic of Korea

Post Office Address: 226 Congressional Lane, Rockville, Maryland 20852 U.S.A.

****

Full name of joint inventor(s): Jong Beom RA

Inventor's signature: _Jong Beom R._   Date: 3/3/99

Residence: Taejeon-si, Korea

Citizenship: Republic of Korea

Post Office Address: Expo APT. 404-506, 464-1, Chonmin-dong, Yusong-ku, Taejeon-si, Korea

****

Full name of joint inventor(s): Sung Deuk KIM

Inventor's signature: _Sung Deuk Kim_   Date: 3/3/99

Residence: Taejeon-si, Korea

Citizenship: Republic of Korea

Post Office Address: ~~Samjong Heights APT. 103-1506, Jonglim-dong, Seo-ku, Taejeonsi, Korea~~ *1122, Woipyong-dong, Seo-ku, Taejeon-si, Korea* Sung Deuk Kim 3/3/99

****

Full name of joint inventor(s): Young Su LEE

Inventor's signature: _/s/_   Date: 2/15/99

Residence: Seoul, Korea

Citizenship: Republic of Korea

Post Office Address: 303, 661-2, Yeoksam1-dong, Kangnam-ku, Seoul, Korea